National Environmental Satellite, Data, and Information Service

Update of CH4 retrieval from AIRS(v6), IASI and CrIS

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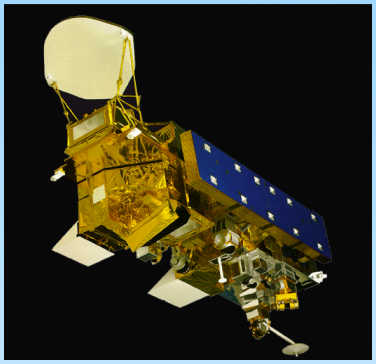
Eric Maddy, Antonia Gambacorta, Thomas S. King

NASA Sounder Science Team Meeting
Nov. 13-16, 2012, Greenbelt, Maryland

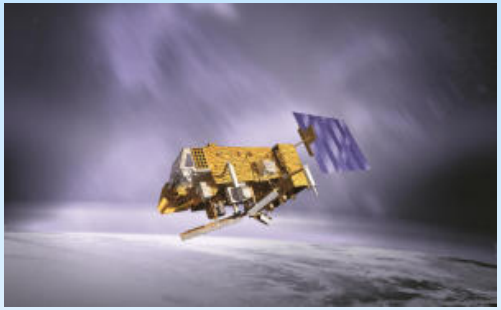
National Environmental Satellite, Data, and Information Service

AIRS, IASI, CrIS

(A plan to derive CH4 and other GHG data of 20+ years)

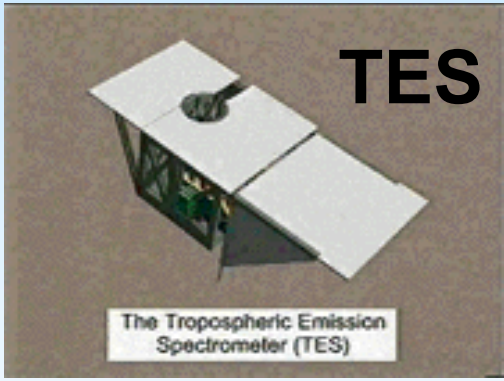


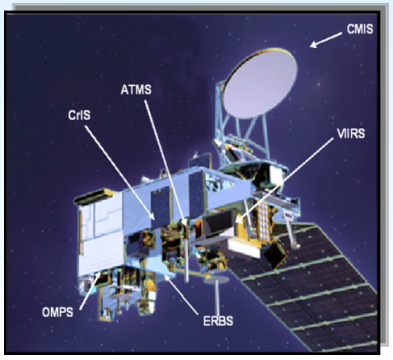
AIRS on NASA/Aqua 1:30 pm orbit (May 4, 2002)



→ **comparison**

IASI on METOP-A(Oct. 19, 2006) METOP-B(Sept 27,2012) 9:30 am orbit





CrIS on NPP 1:30 pm orbit (Oct.28,2011) and JPSS

Outline

- Summary of AIRS-V6 CH4 as compared to V5;
- Validation of IASI CH4 and its improvement;
- Current status of CH4 retrieval from CrIS on Soumi NPP.

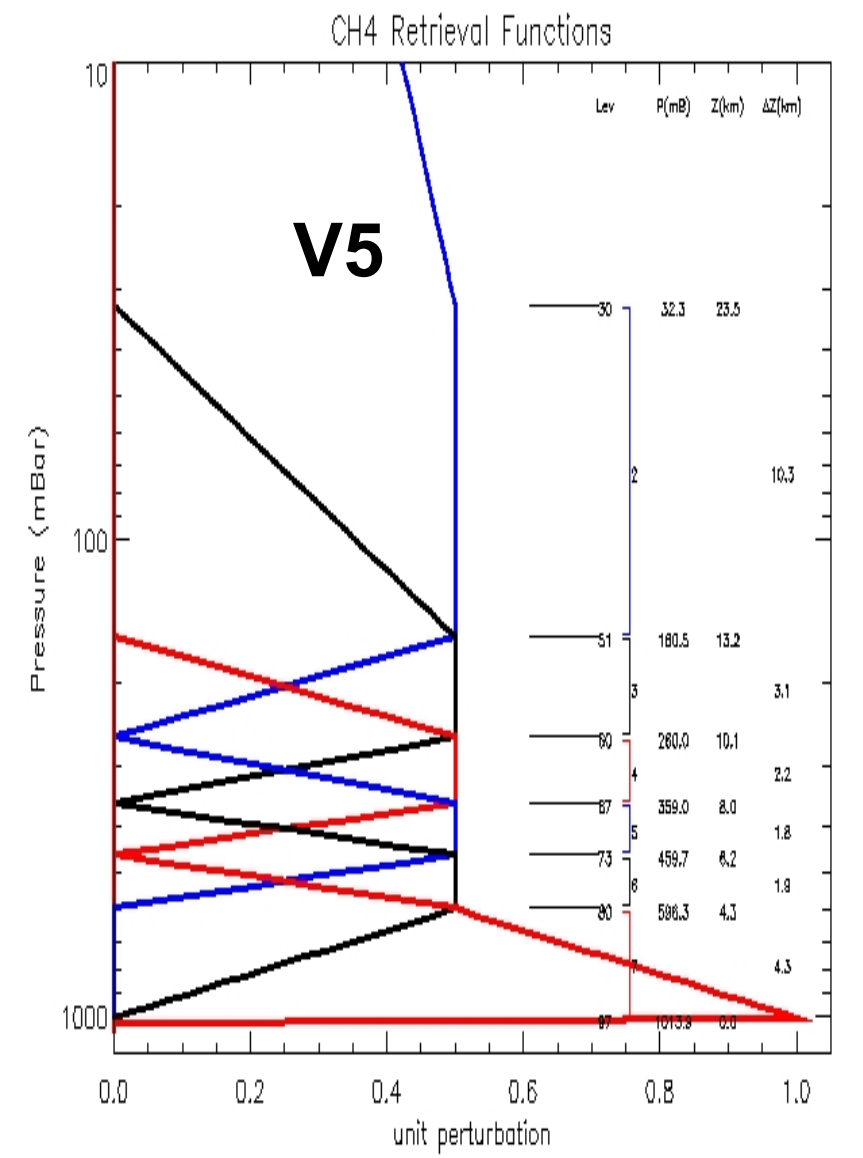
- Some comparison of CH4

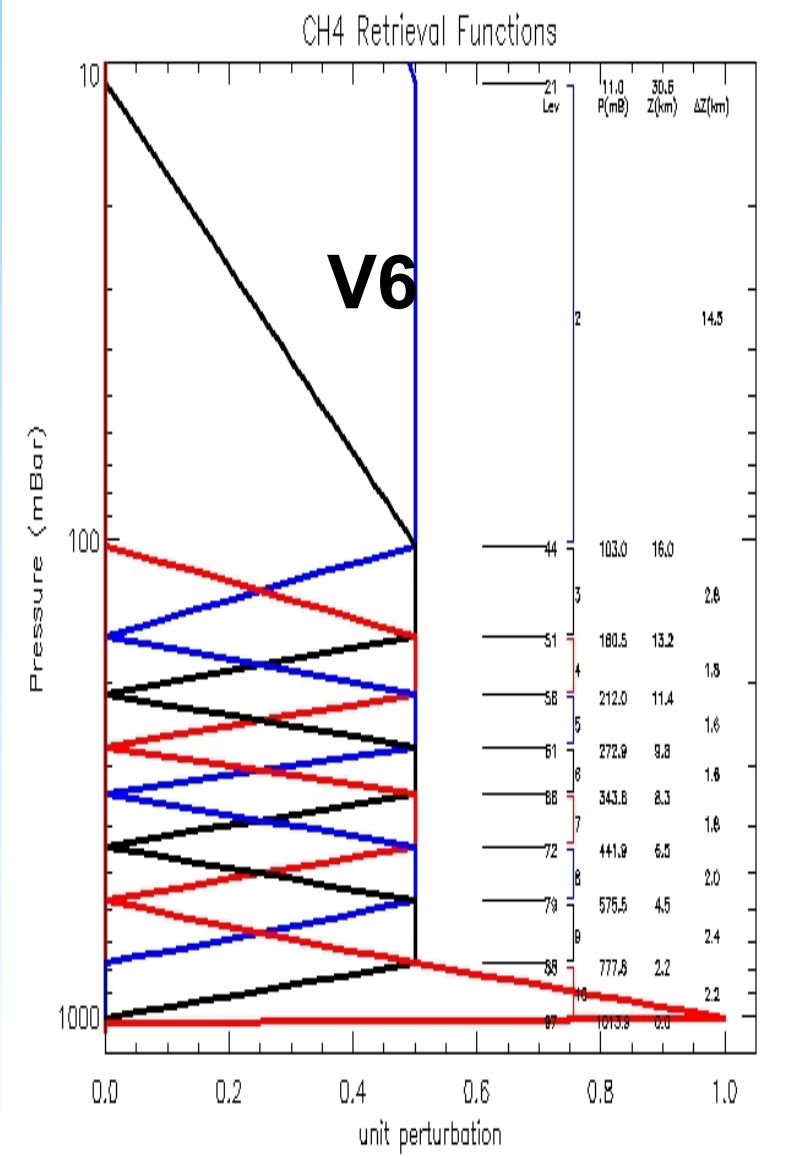
1. Among CrIS, IASI and AIRS-v6 (5/15/2012);
2. Seasonal cycle of CH4 over South Asia and Siberia from AIRS-v5 (10 yrs) and IASI (5 yrs);
3. AIRS-v6 vs GOSAT TIR CH4;

- One major effort to derive a better CH4 product in the polar region

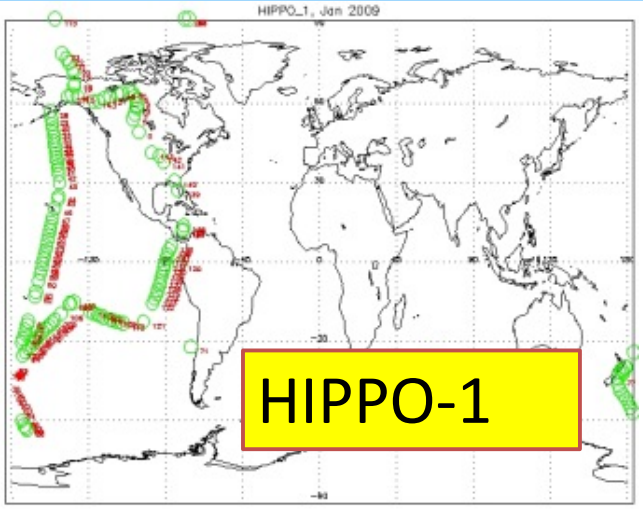
- Summary

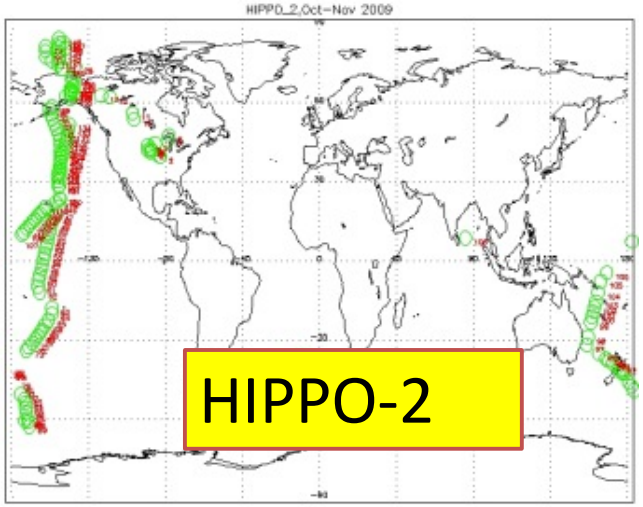
More Retrieval Layers

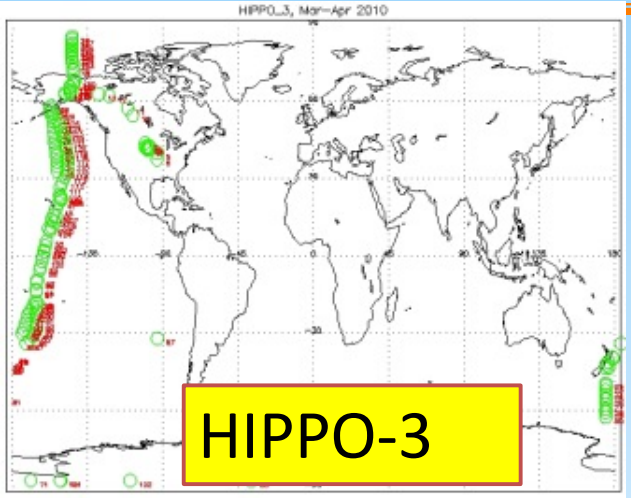


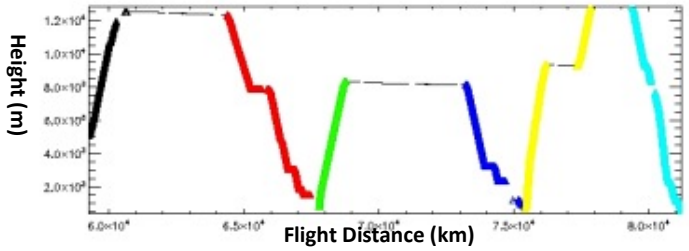


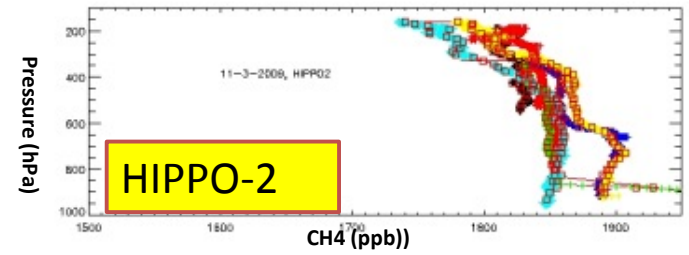
Backup of aircraft measurement for tuning and Validation









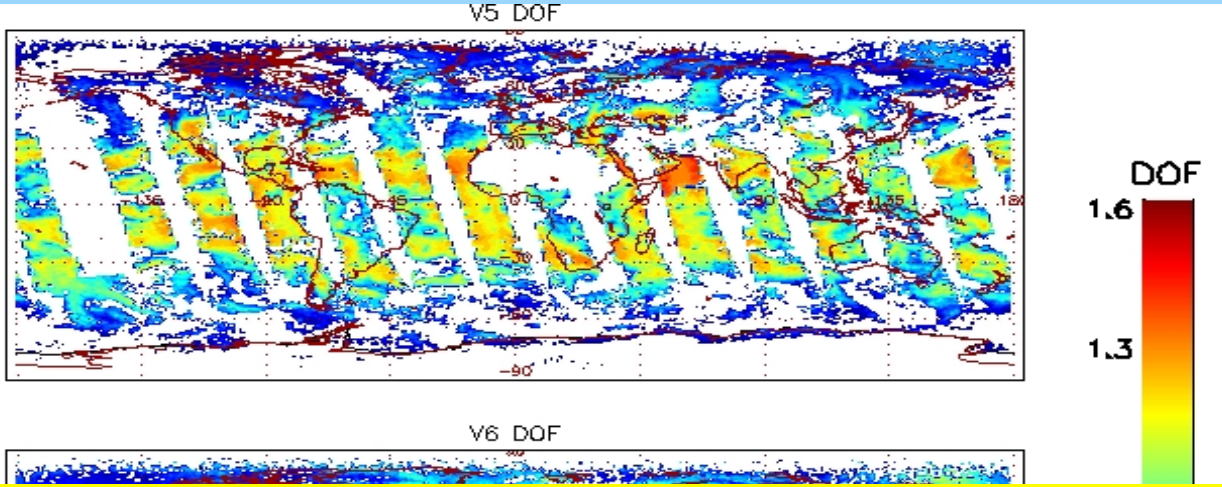


HIPPO -1 (Jan 2009) ; HIPPO -2 (Oct/11, 2009); HIPPO-3 (March/ April,2010) (HIAPER Pole-to-Pole Observations of Carbon Cycle Greenhouse Gases study)

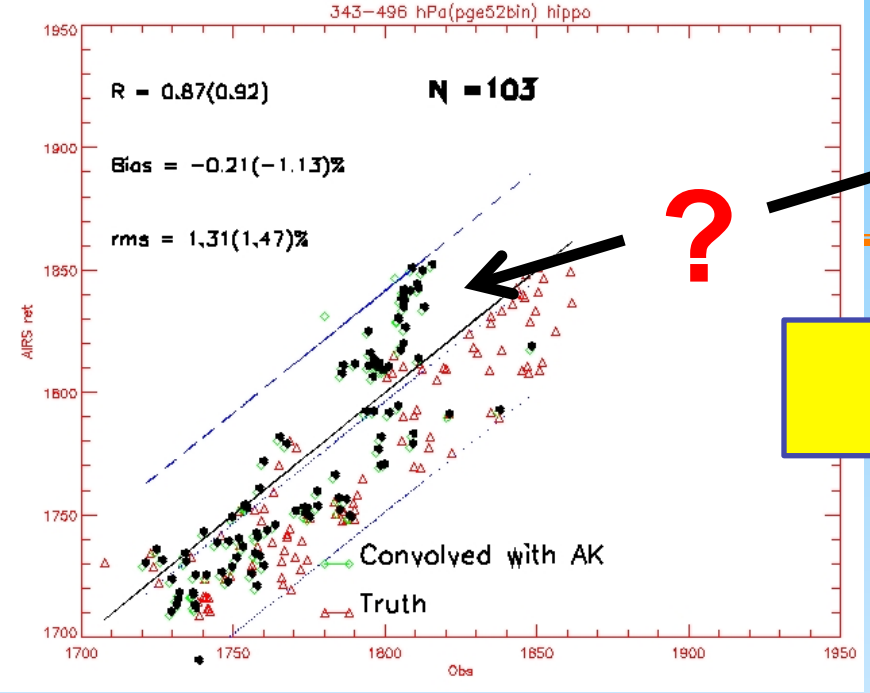
Optimization of CH4 retrieval in V6

	V5 (Research Product)	V6 (Standard product)
Retrieval layers	7	10
Channel s	71	58
First guess		updated
Quality Flag		well set
tuning	empirical	Using more aircraft data

AIRS V5 vs V6 (March 27,2010)



- V6-CH4 has improved QC;
- V6-CH4 has larger DOF than V5;
- V6-CH4 has a better sensitivity lower troposphere;
- Small bias and RMS error



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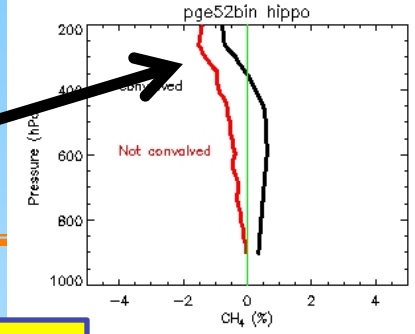
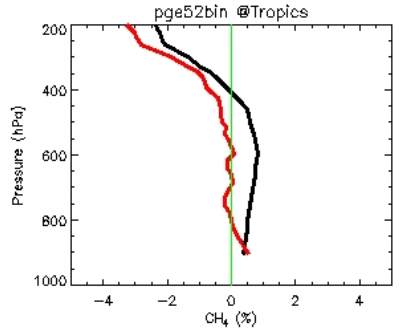
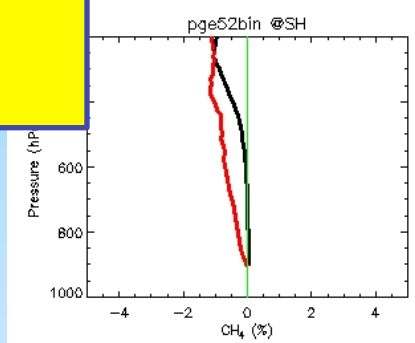
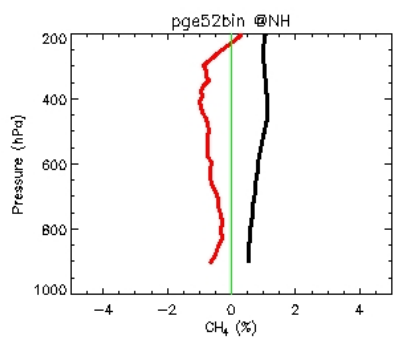
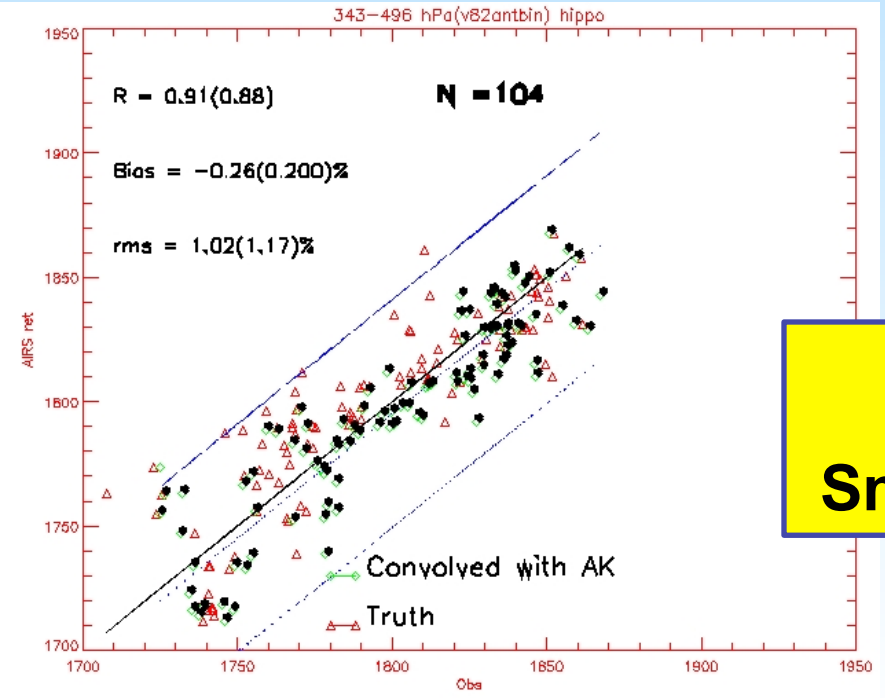


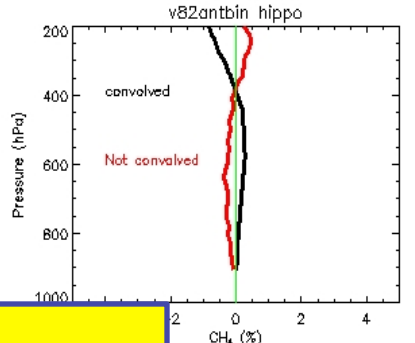


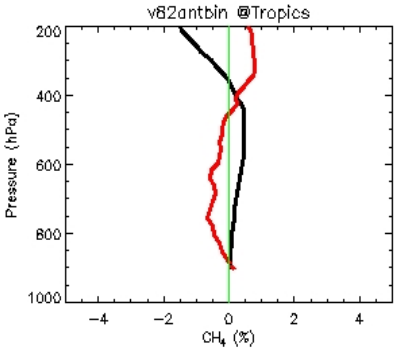


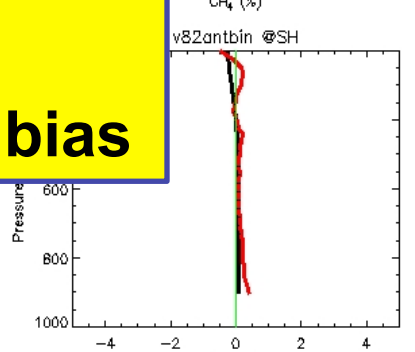


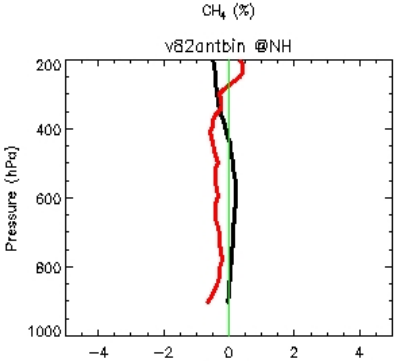
V5





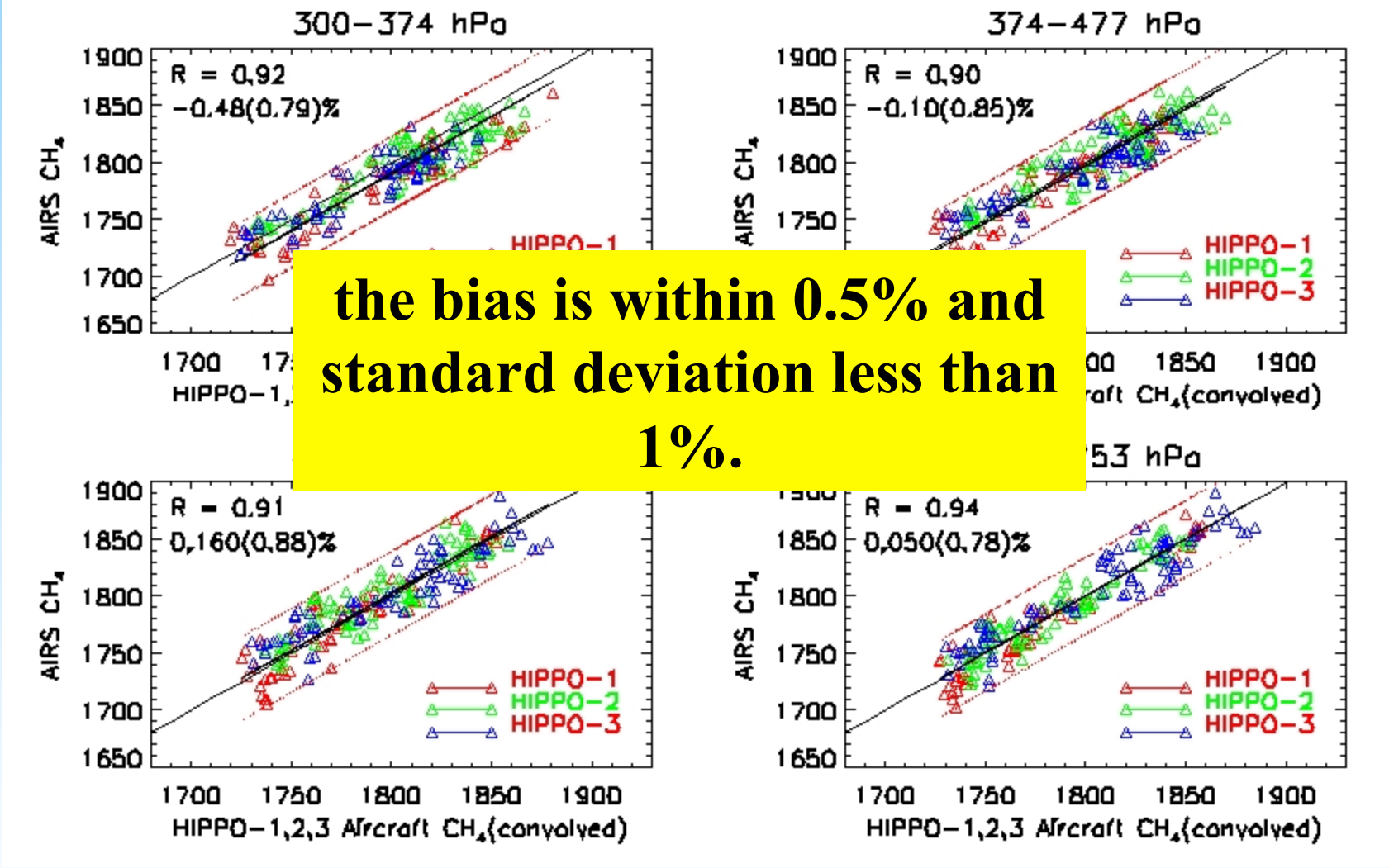






V6
Smaller bias

Scatter plot of AIRS vs In-situ



the bias is within 0.5% and standard deviation less than 1%.

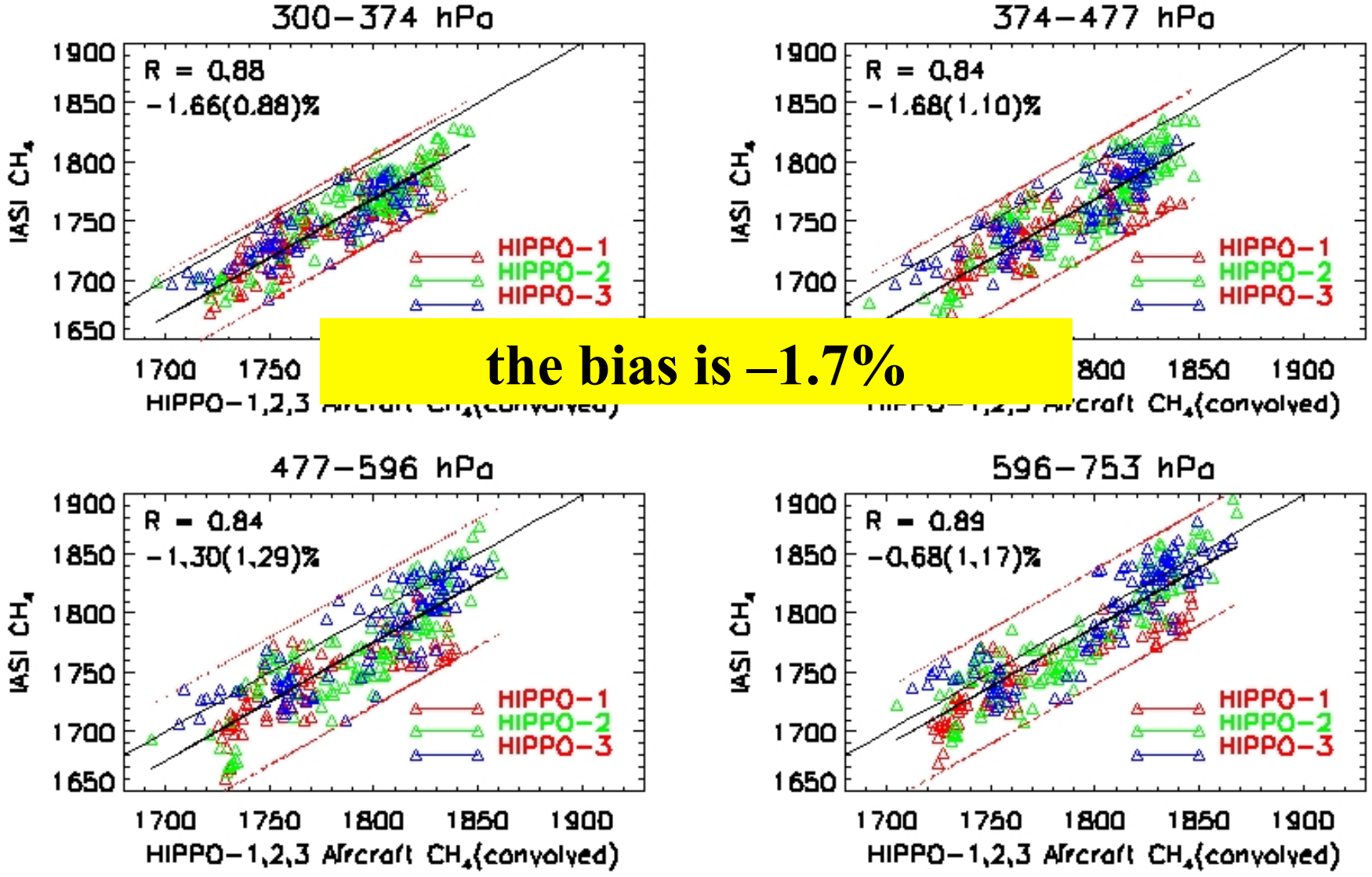
IASI CH4 Validation and Improvement

- New Quality control is recommended
- Recent Validation
- Improvements by adopting the improvement in AIRS-v6

→

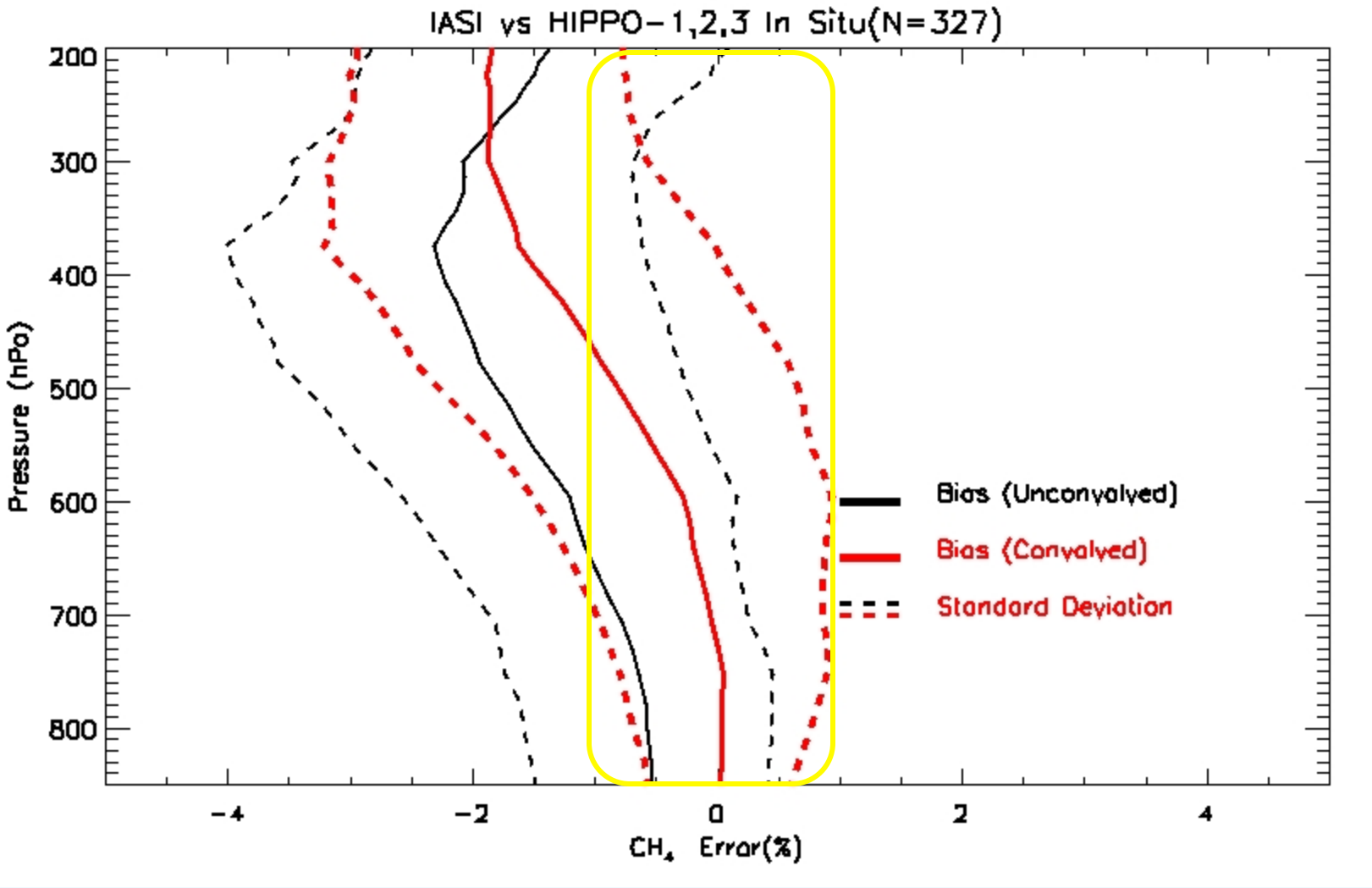
a paper is submitted to Atmos. Meas. Tech.

Scatter plot of IASI vs In-situ CH4



the bias is –1.7%

Error of IASI CH4



IASI CH4 have been generated on NOAA CLASS system;

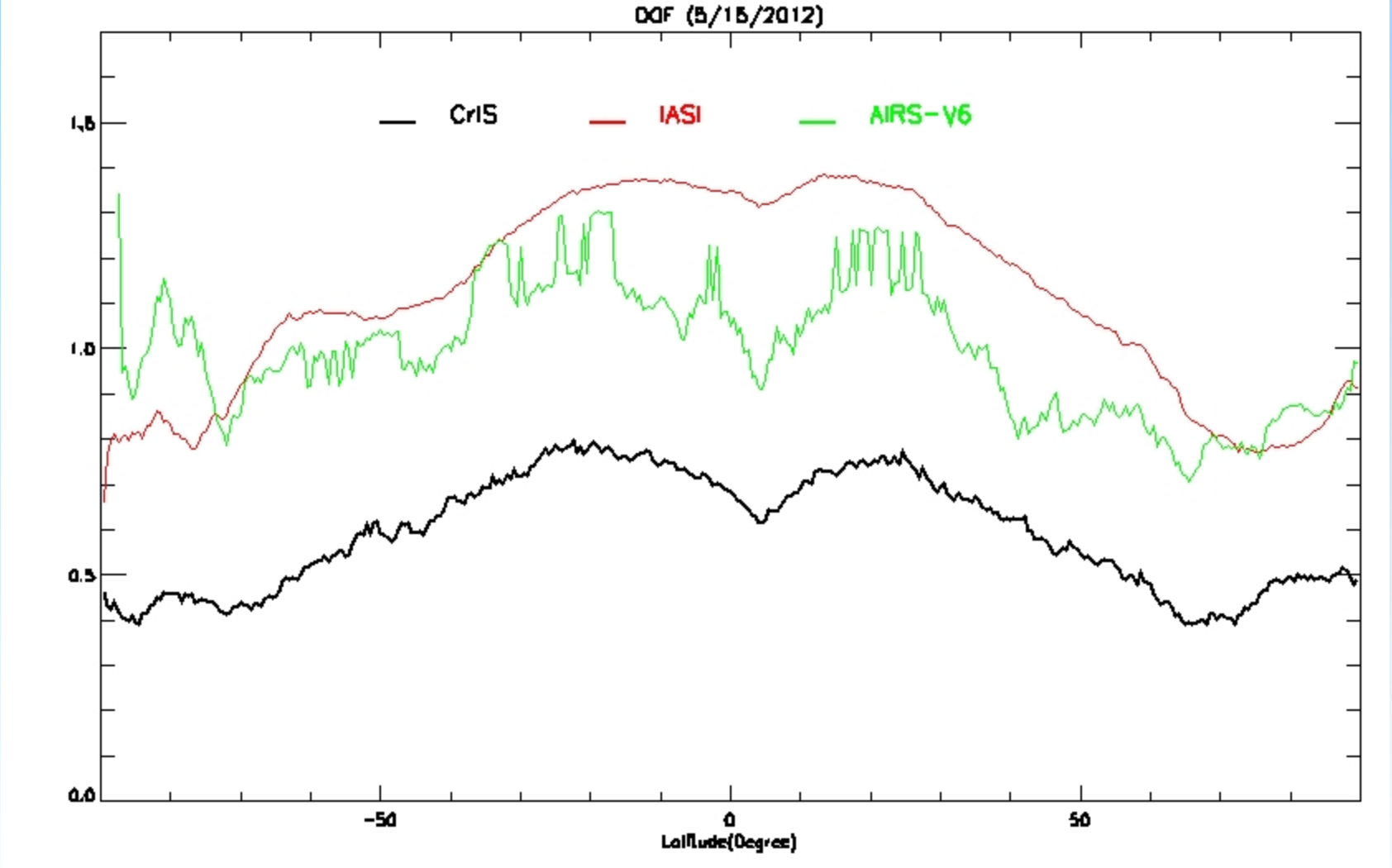
CH4 retrieval from CrIS on Soumi NPP

on *NOAA Unique CrIS ATMS Processing System* (*NUCAPS*)

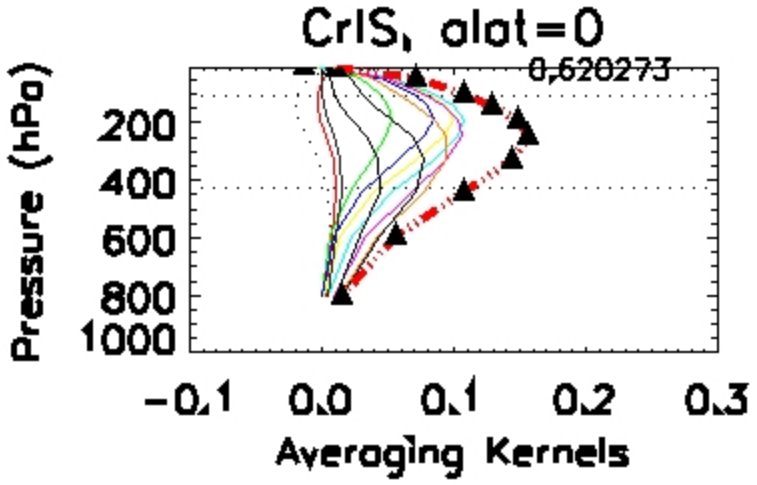
(more detail see Antonia's talk tomorrow)

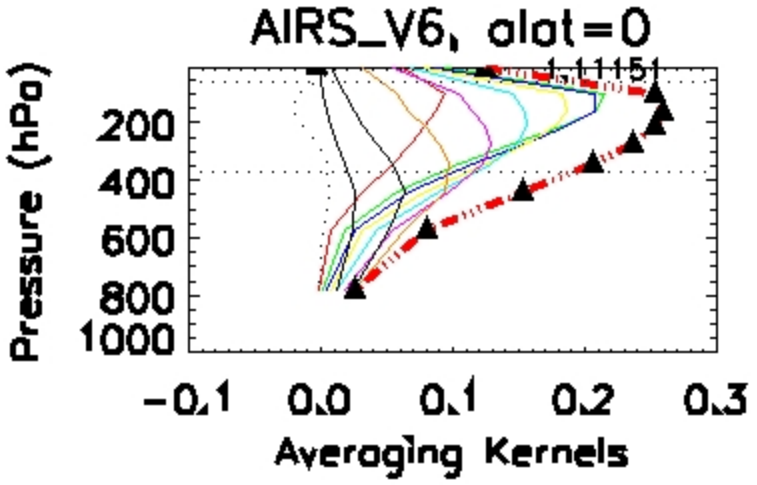
Comparison of CH4 from AIRS, IASI and CrIS using data on 5/15/2012

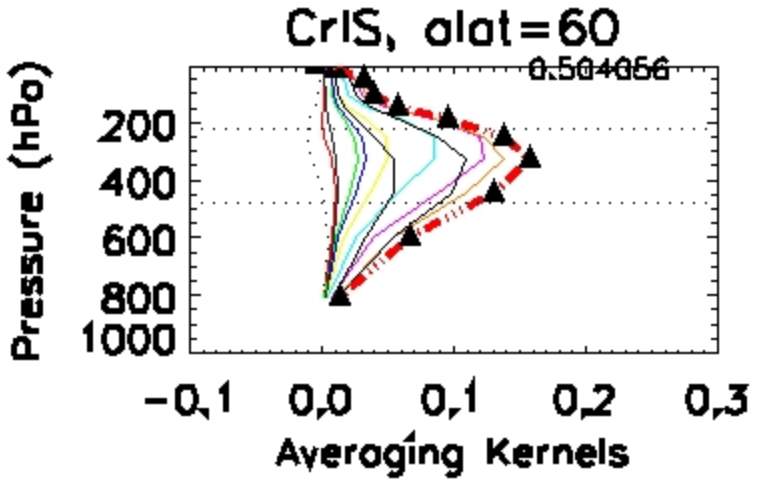
Comparison of DOF in different latitude 5/25/2012

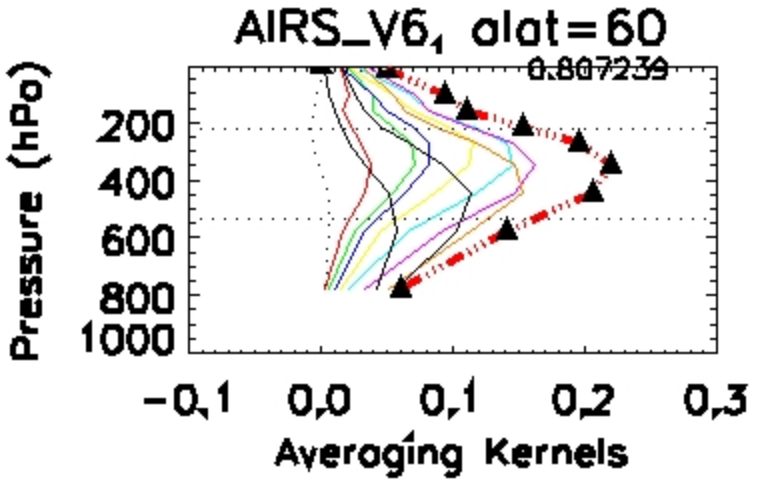


Comparison of Averaging Kernels 5/15/2012

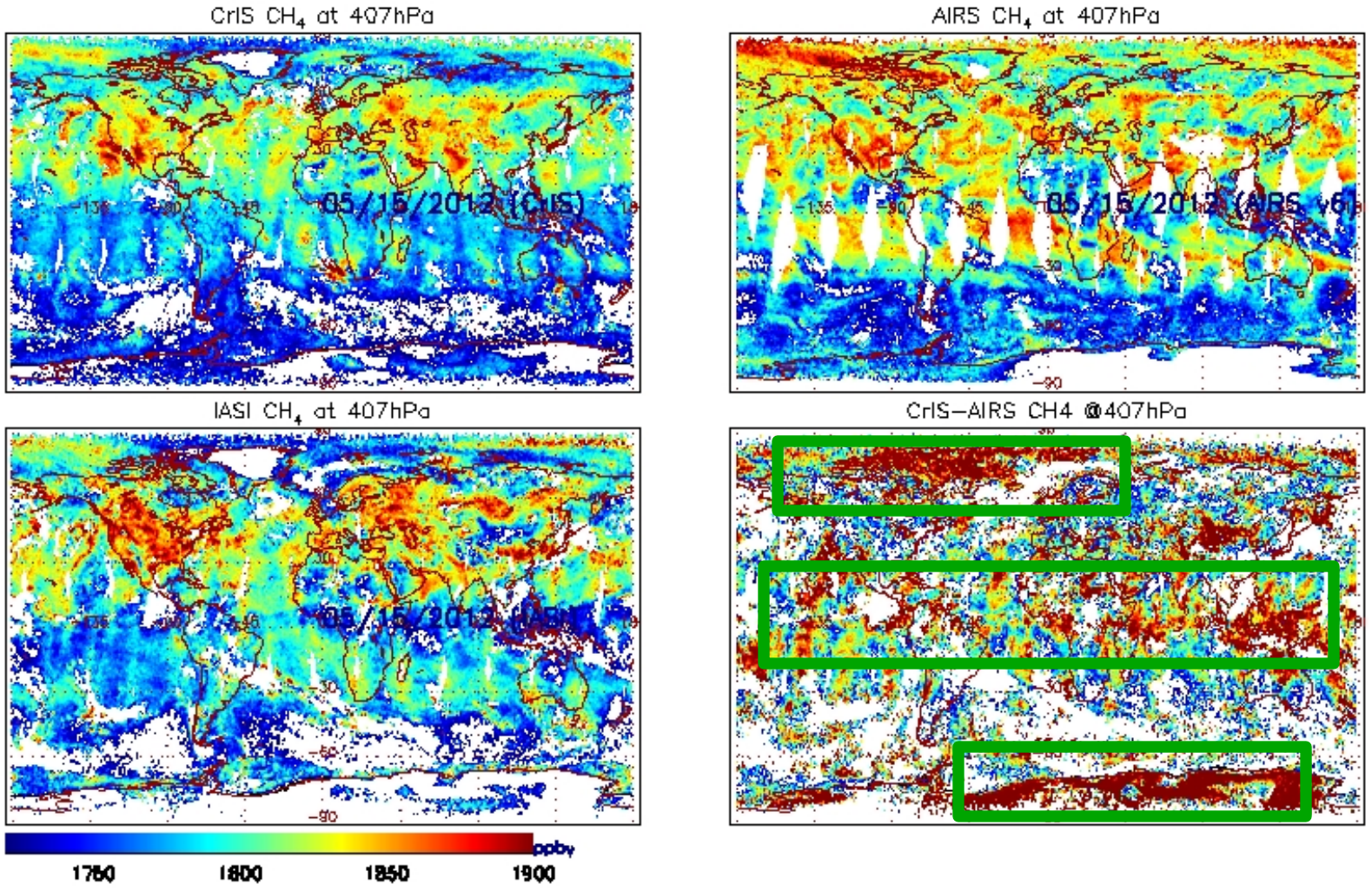




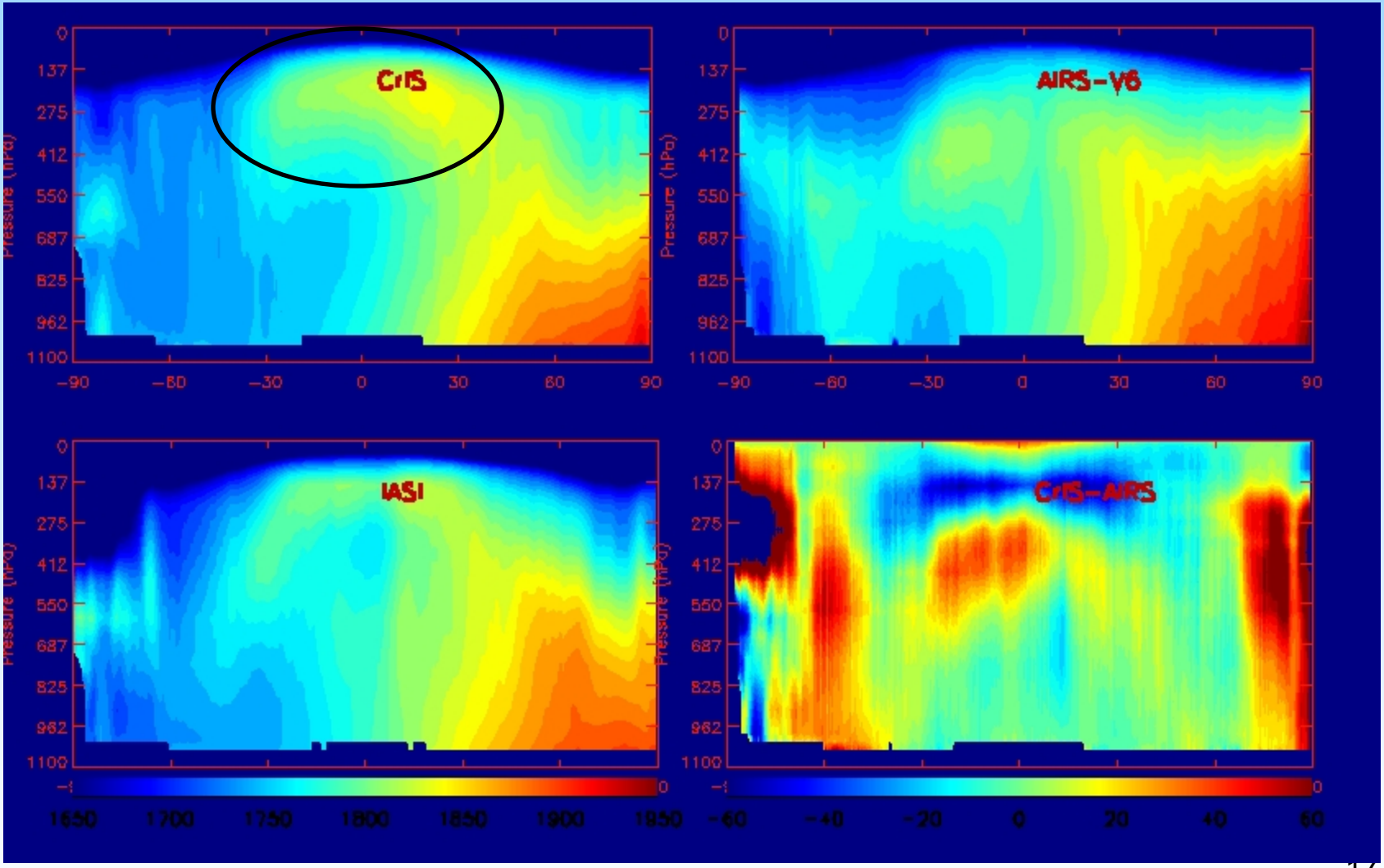




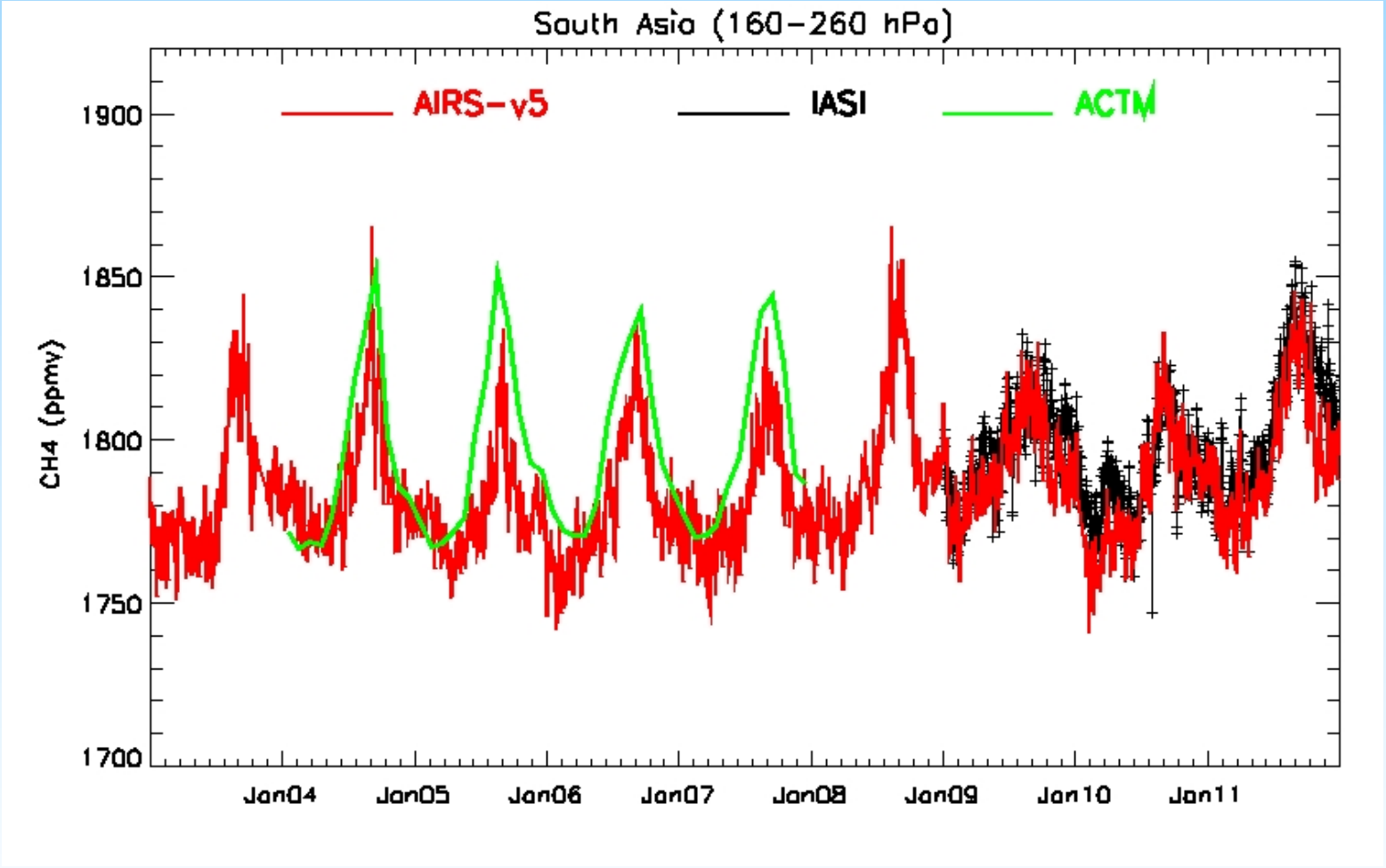
Comparison of CH4 at 400 hPa from CrIS, AIRS, IASI (5/15/2012)



Mean Profiles in different latitude



A very good agreement in observing the CH4 enhancement over the south Asia



Xiong, X., et al, 2009, Methane Plume over South Asia during the Monsoon Season: Satellite Observation and Model Simulation, ***Atmos. Chem. Phys.***, 9, 783-794, 2009 .

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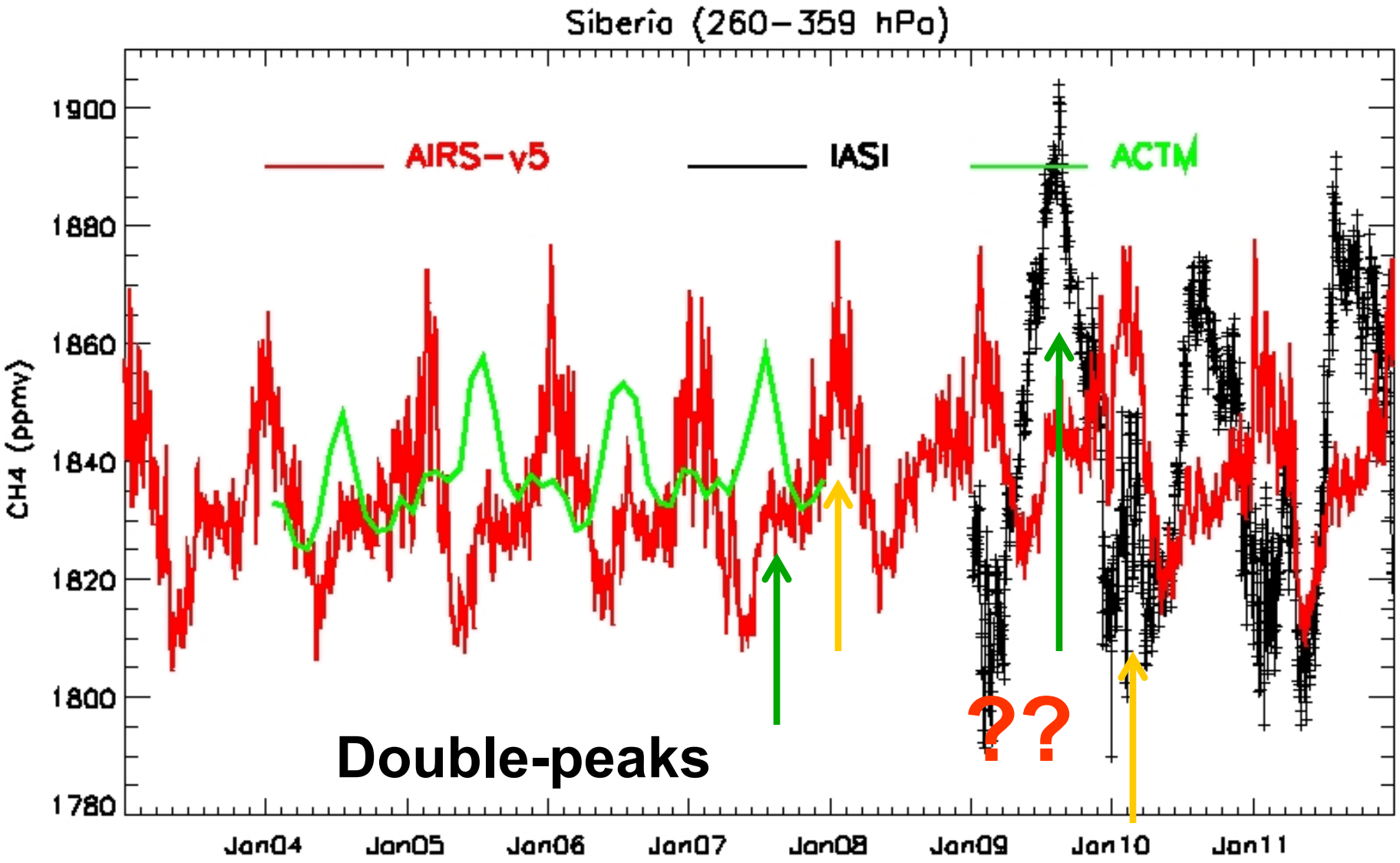
In Siberia, a much larger seasonal cycle from IASI than from AIRS-V5



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Comparison of CH4 retrieved from GOSAT TANSOTIR, AIRS and Aircraft Measurements

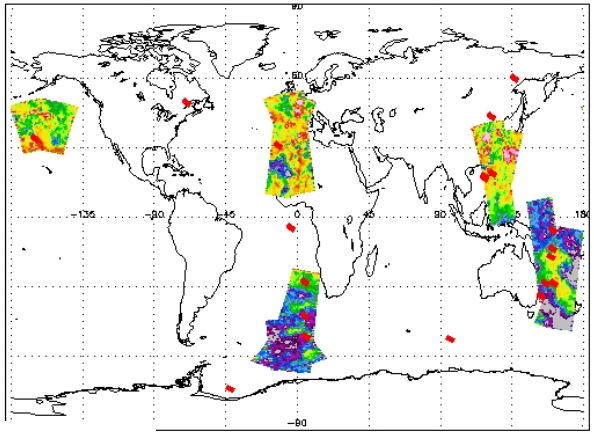
Xiaozhen (Shawn) Xio

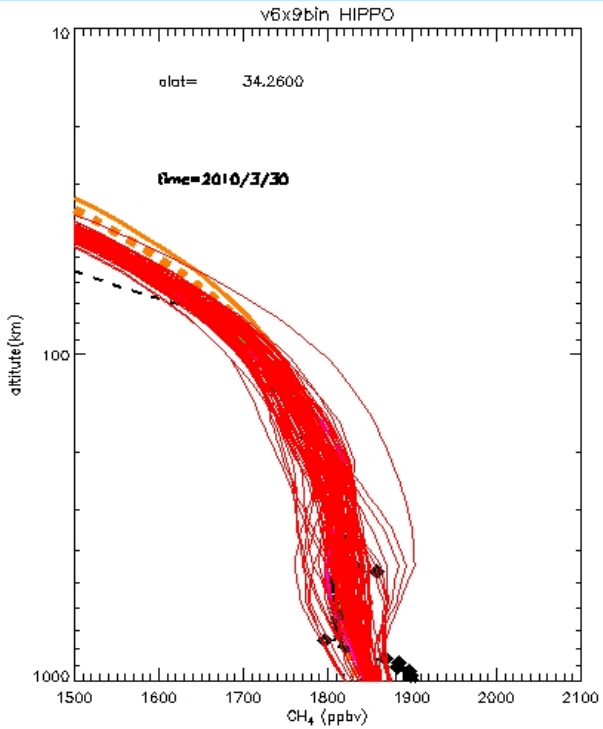
Chris Barnet(1),

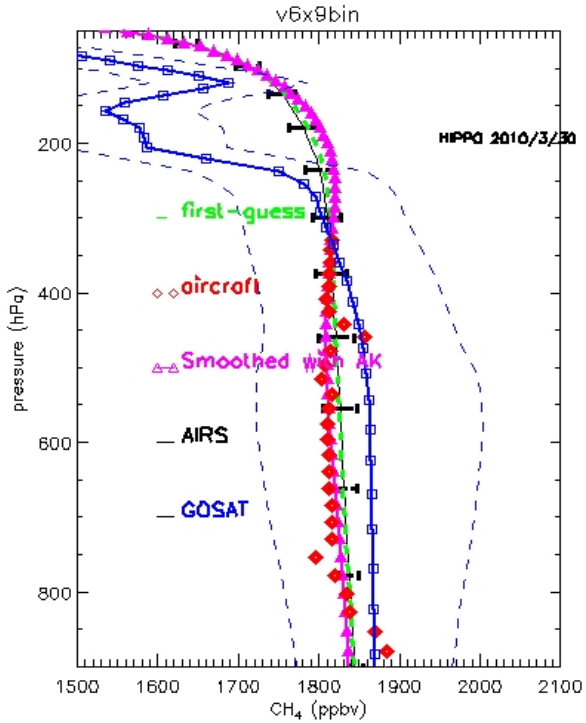
Sachiko Hayashida(5),

Hidekazu Matsueda(7)

Evan Manning(8), T







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adena, CA, USA

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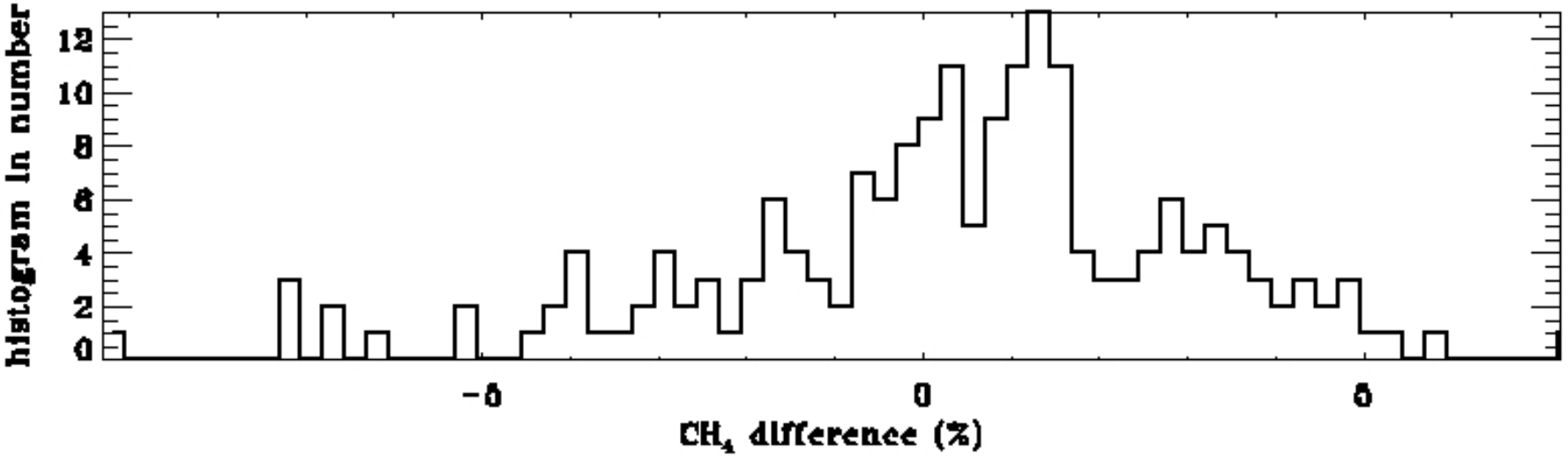
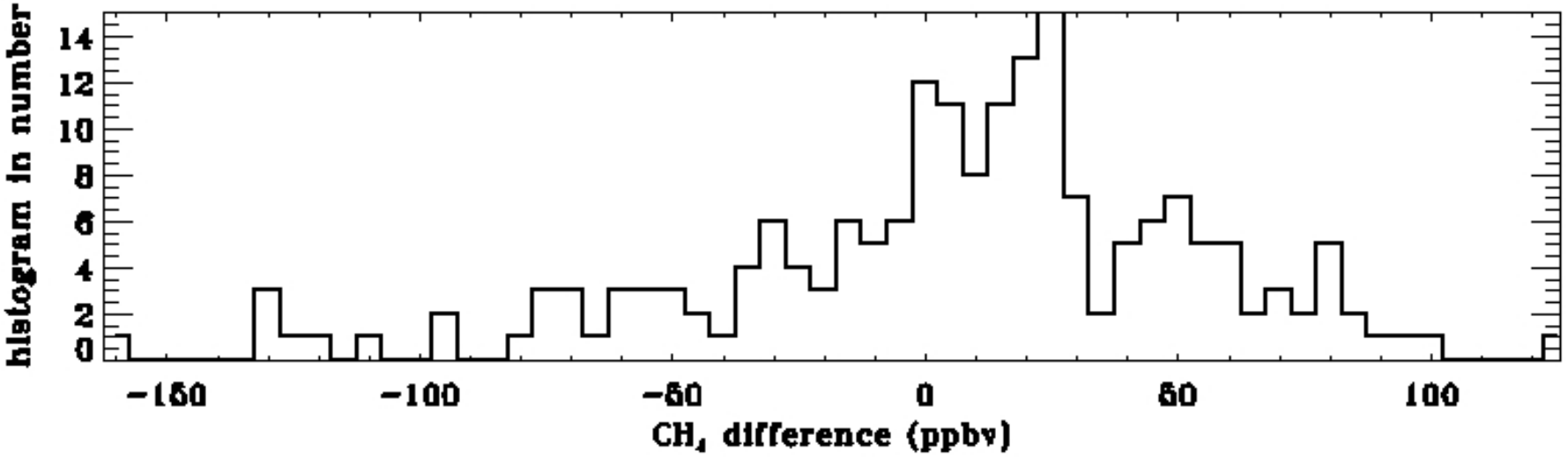
Histogram of GOSAT minus AIRS (300-500 hPa)





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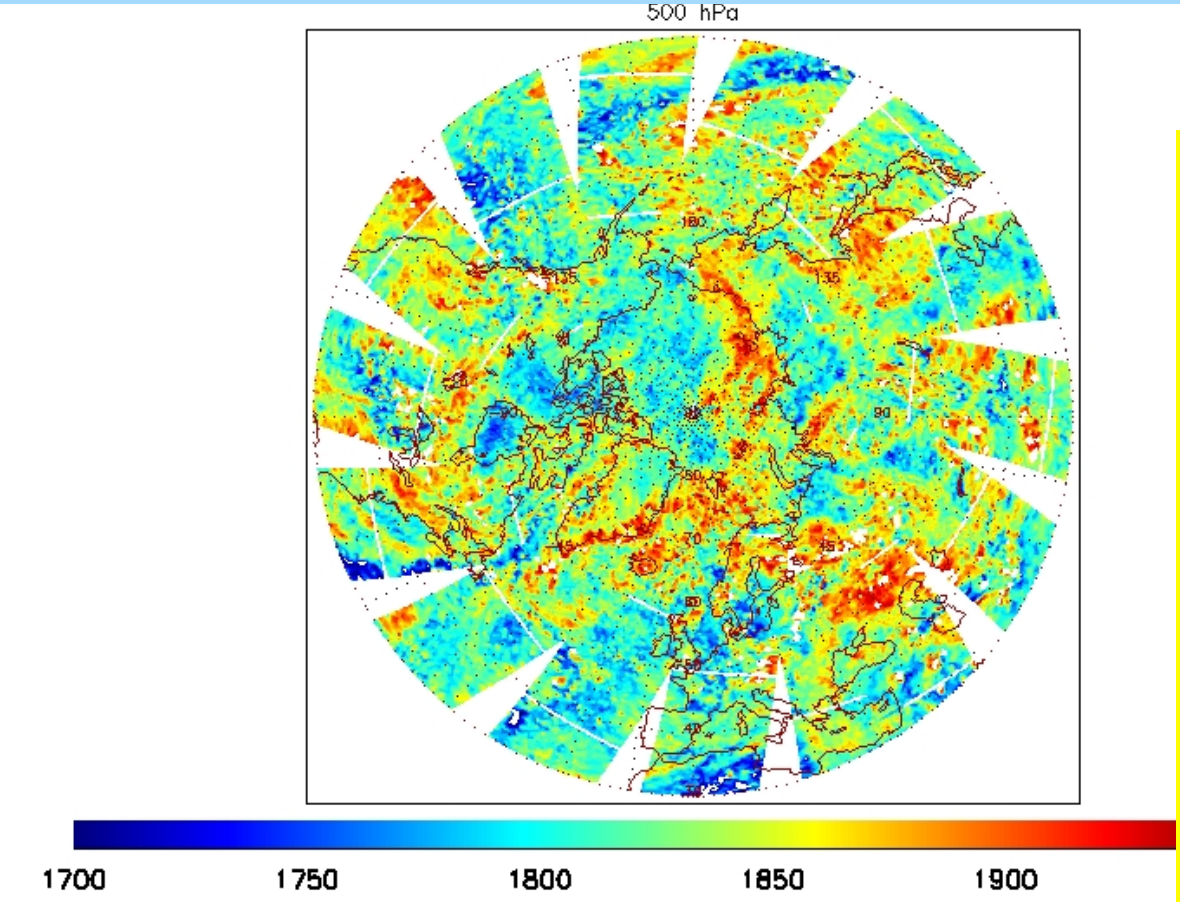
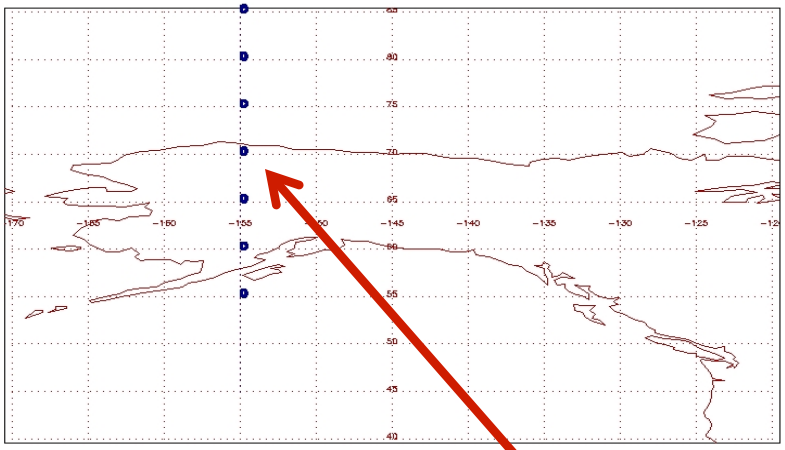
To generate a long-term record for monitoring the polar CH4 emission under the impact of global warming



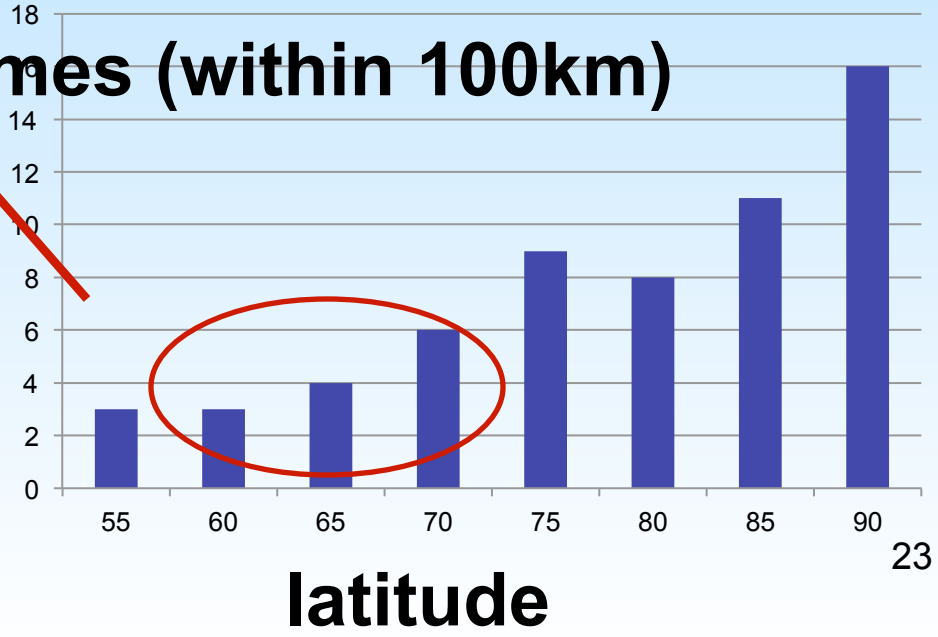
Multiple observations from AIRS per day over the polar regions

- Current algorithm is not optimized in the polar;
- Information of multiple observations per day has not been well used in L3 product;
- We are investigating to better characterize the retrieval in the polar and use better first guess

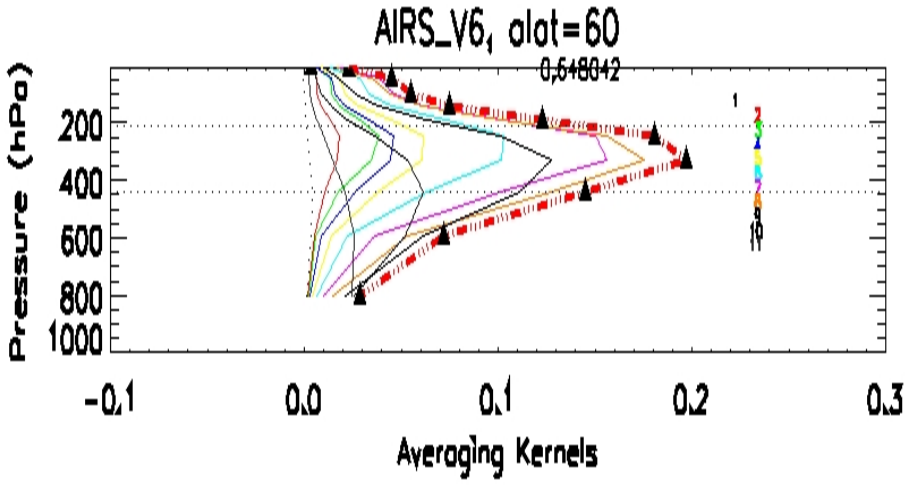
CH4 Observations over Alaska

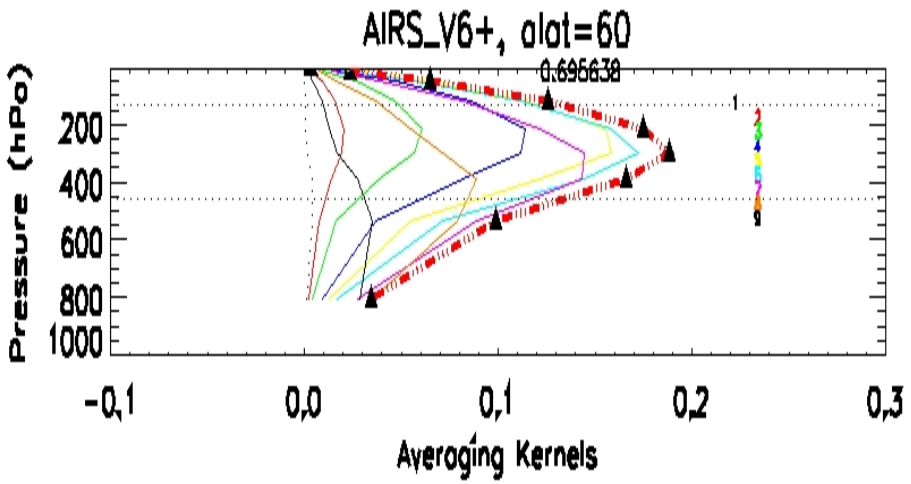


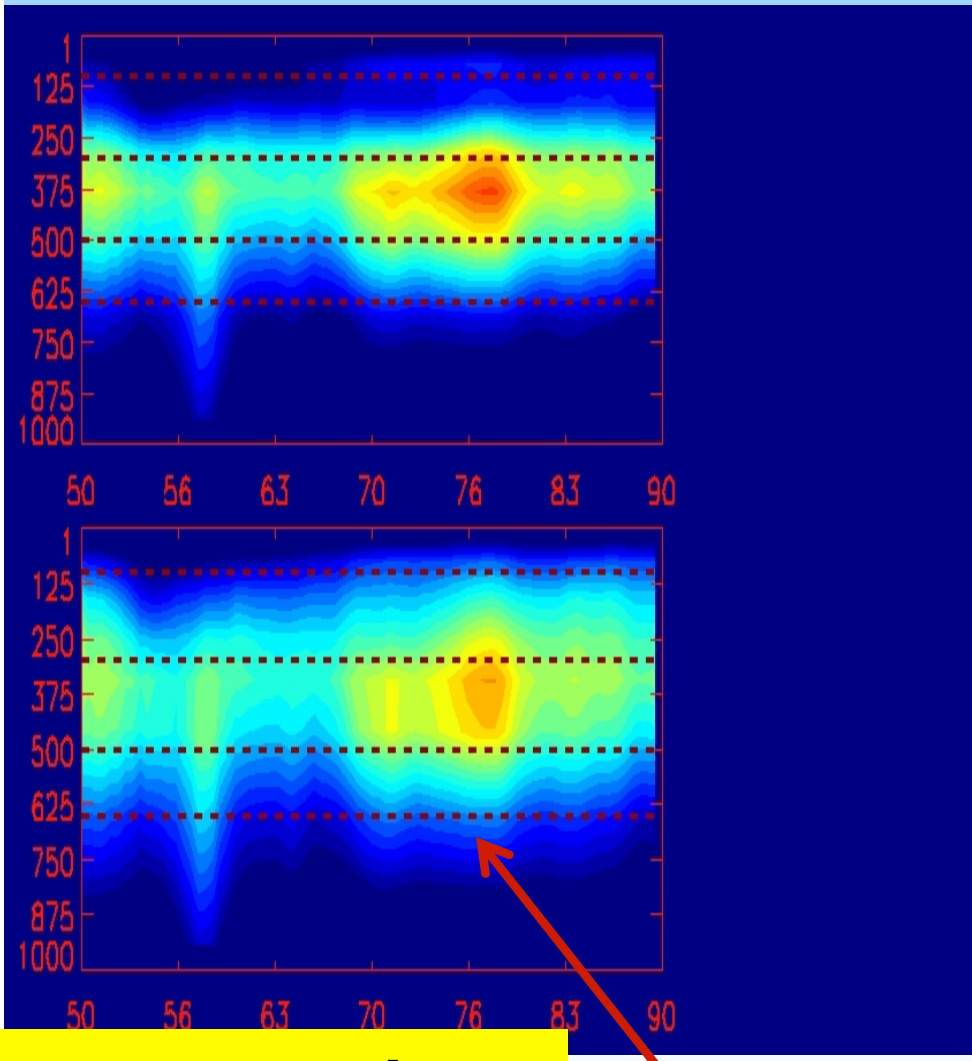
CH4 release from wetland and thawing permafrost are very sensitive to global warming. Its trigger will be a disaster.



Example: Optimization for the Polar CH4 retrieval (2009/01/13)







Better sensitivity to lower troposphere

Summary (1/2)

1. Significant improvements in AIRS-V6 retrievals and setting of quality flag has been made, and the bias is within 0.5% and standard deviation less than 1%. More validation will be done as soon as all V6 data are available.

2. Validation to NOAA CLASS IASI CH4 product shows IASI is lower biased by ~1.7%. Recent improvement in AIRS-V6 will be incorporated in IASI CH4 retrieval.

3. CrIS has lower sensitivity and smaller DOF than AIRS and IASI. It is expected that better CH4 product can be derived from the full spectral resolution CrIS data.

Summary (2/2)

- **AIRS and IASI CH4 shows a good agreement in observing the seasonal cycle over the south-Asia, however, IASI observed a much larger summer increase in the polar region → which will be further analyzed using data from AIRS-V6.**

- **Comparison among AIRS, IASI and CrIS CH4 products indicated that more works need to be done to generate a consistent, long-term CH4 product for climate change study, and one effort we are focusing now is to derive a better product in the polar regions. This can become part of AIRS-v7.**

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NOAA CLASS

All these improvements in V6 are based on extensive validation

Aircraft measurements used include

1. Aircrafts measurements from NOAA/ESRL/GMD (the only one used for V5 optimization)
2. Intex-A (2004), -B(2006)
3. START08(2008)
4. ARCTAS(2008)
5. HIPPO-1, -2(2009), -3(2010)

   HIPPO-4, -5 data have not been released to public

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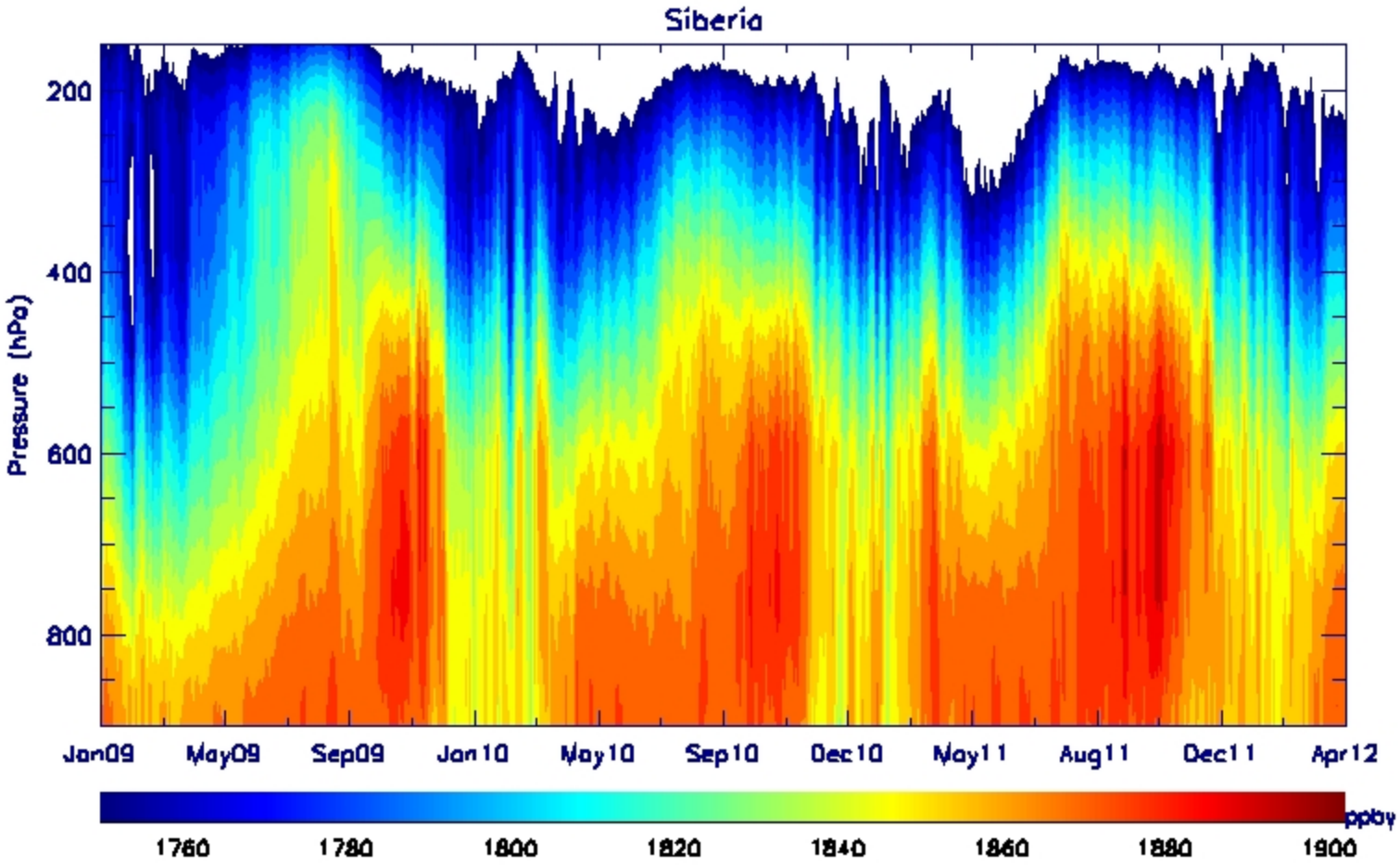
CH4 over Siberia



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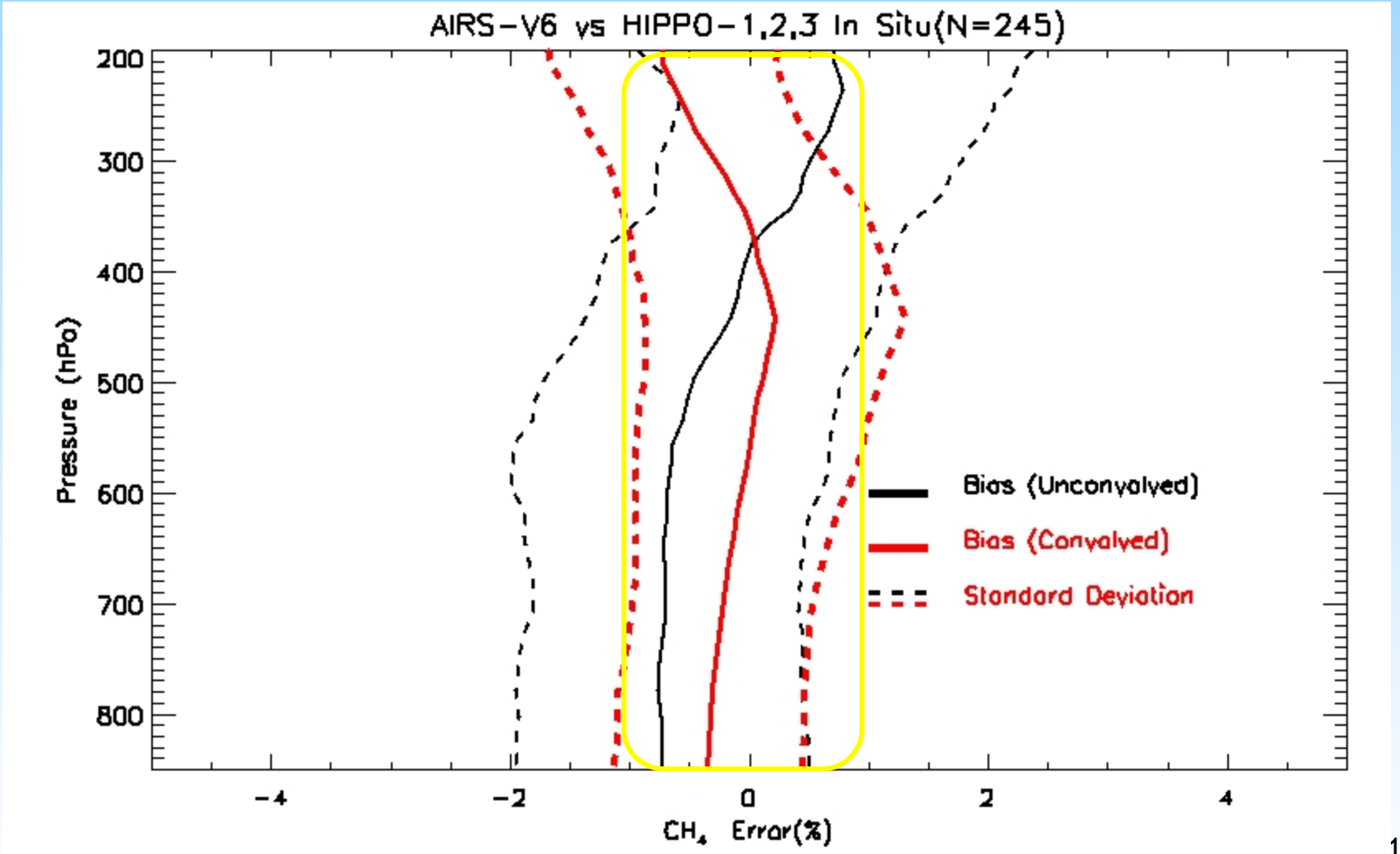
Error of AIRS-V6 vs aircraft measurements



A paper about the setting of QC and validation is in preparation

Setting of QC

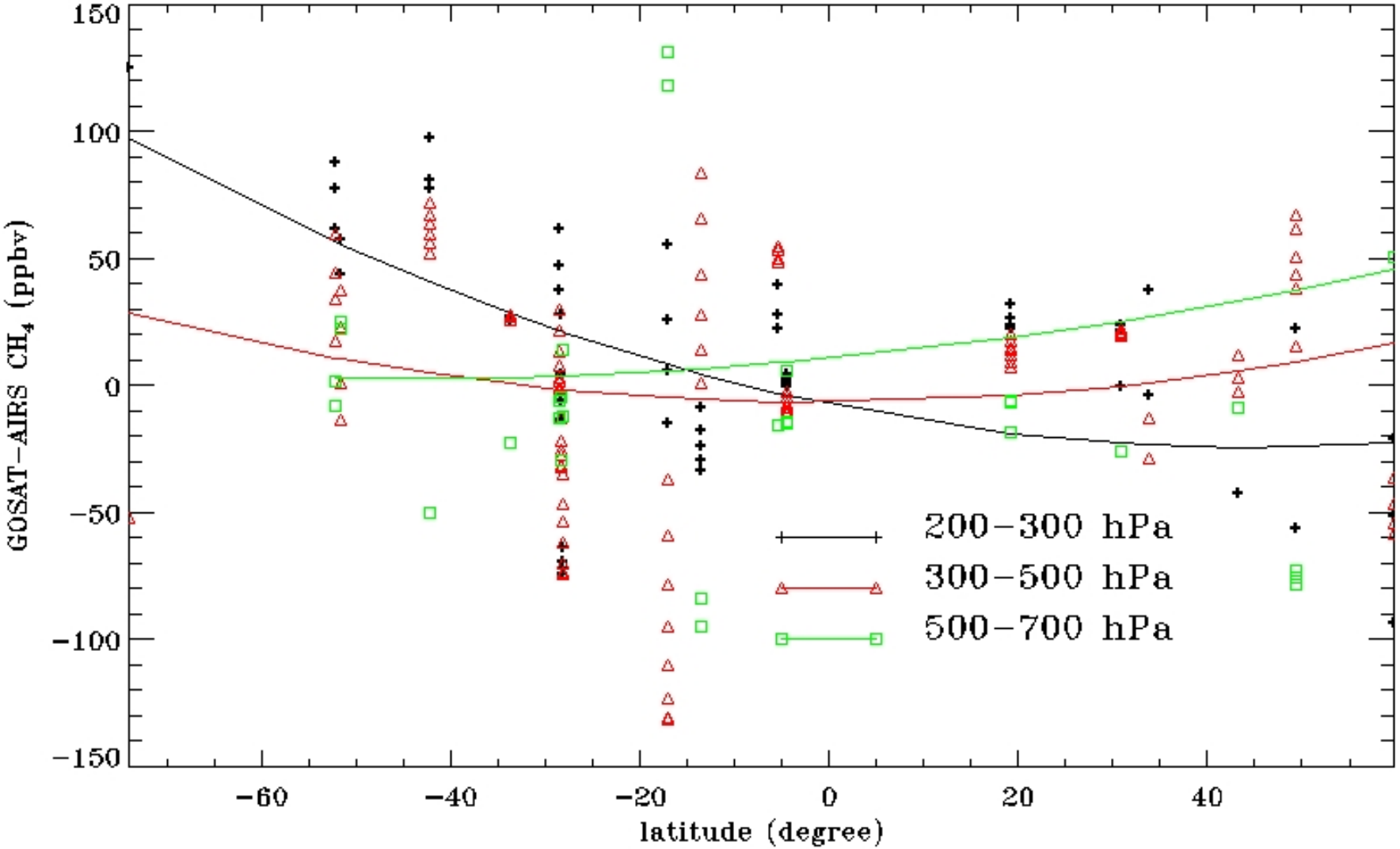
Both infrared and microwave retrievals of water vapor and temperature are successful;

Residual (observation minus RTA computation) relative to the estimated errors(including error in instrument, cloud-clearing, forward model) is less than 3 (Chi2 < 3);

Total FOR Cloud fraction, solving for two layers of clouds, is less than 1.5 ;

DOF is greater than 0.3

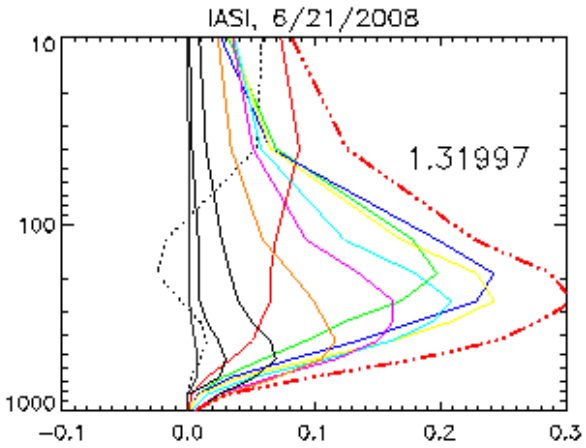
Comparison of AIRS vs GOSAT @ three layers

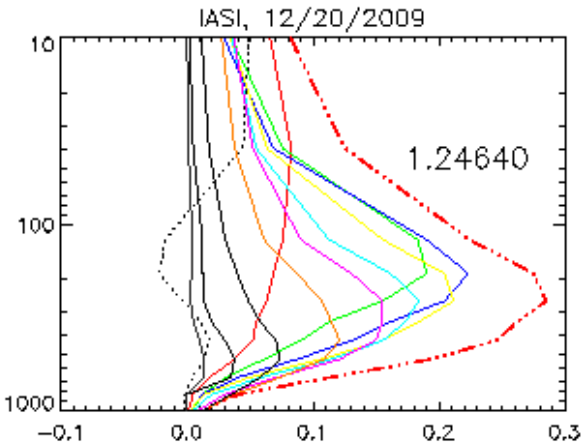


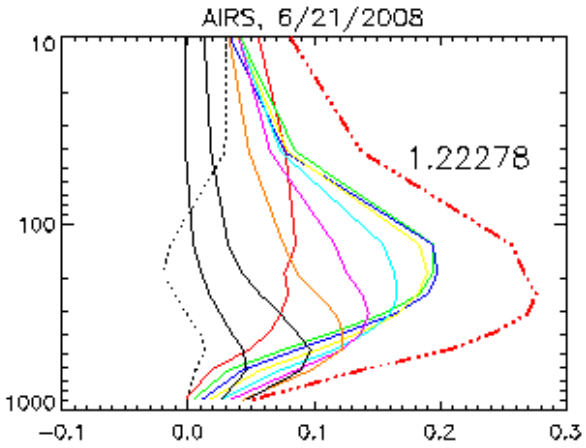
Comparison of Averaging Kernels (6/21/2008, 12/20/2009)

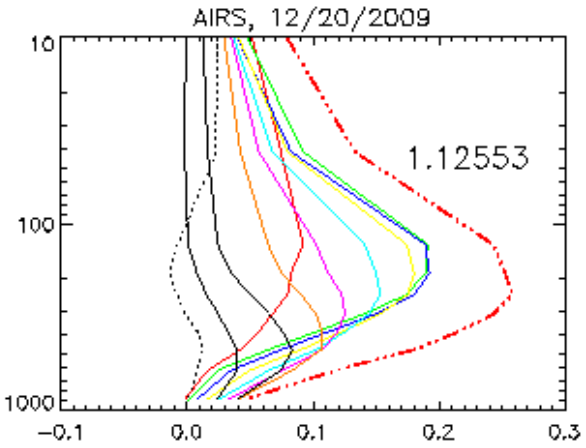
IASI →

AIRS →

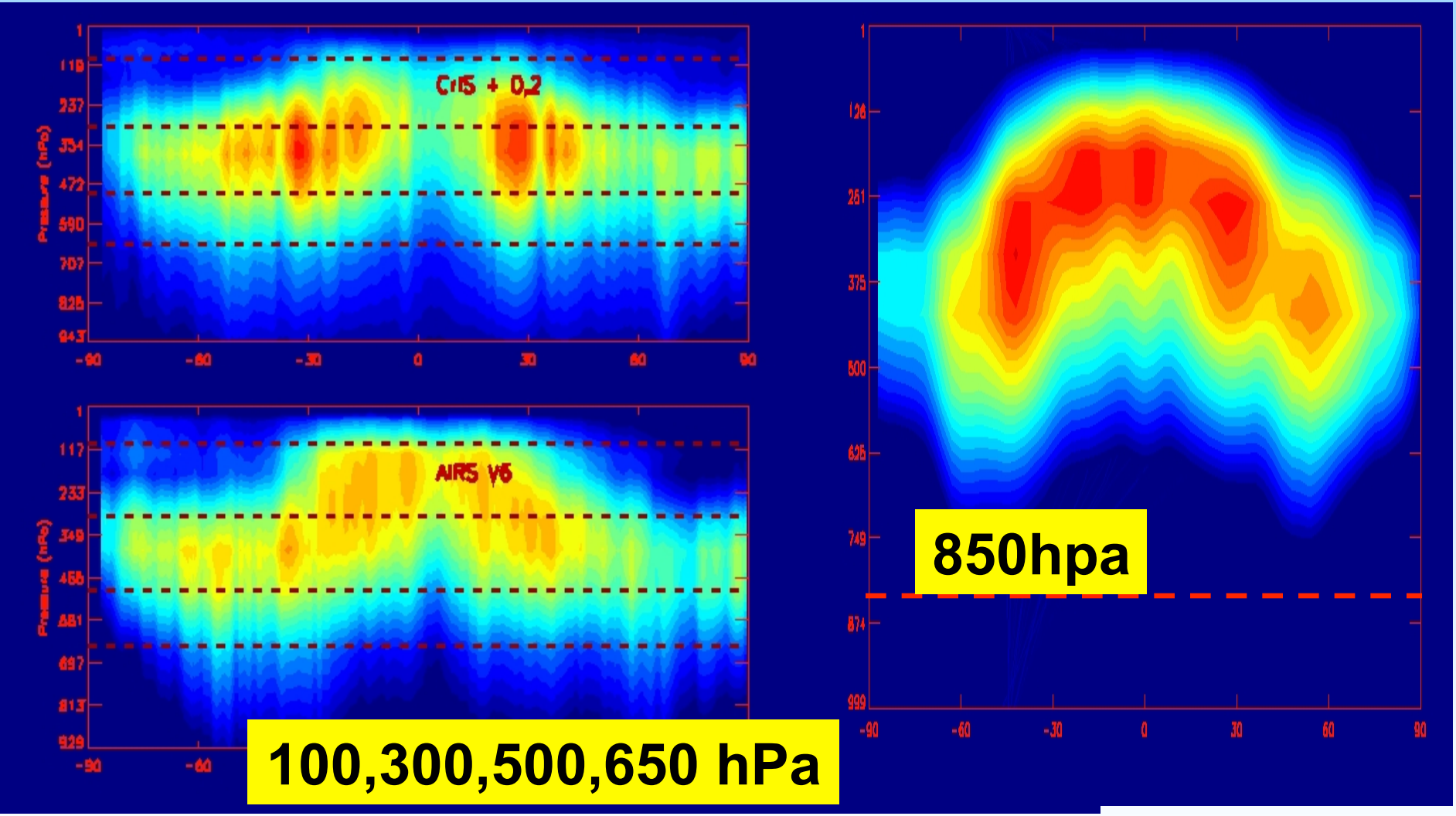








Area of Aveaging Kernels in different latitude



5/15/2012

IASI (April, 2010)

Lower Bias in IASI, CrIS